R E P O R T R E S U M E S

ED 003 549 56

THE EFFECTIVENESS OF FILMED SCIENCE COURSES IN PUBLIC SECONDARY SCHOOLS.

BY- POPHAM, W. JAMES SADNAVITCH, JOSEPH M.
KANSAS STATE COLL. OF PITTSBURG

REPORT NUMBER NDEA-VIIA-091 PUB DATE AUG 60
EDRS PRICE MF-$0.18 HC-$2.92 73P.

DESCRIPTORS- ACADEMIC ACHIEVEMENT, *CHEMISTRY, COURSE ORGANIZATION, *HIGH SCHOOLS, *INSTRUCTIONAL FILMS, INSTRUCTIONAL IMPROVEMENT, MEDIA RESEARCH, *PHYSICAL SCIENCES, *PHYSICS INSTRUCTION, PROGRAM EVALUATION, ACHIEVEMENT TESTS, SECONDARY EDUCATION, PITTSBURG, KANSAS

A STUDY WAS INITIATED IN 12 SECONDARY SCHOOLS TO INVESTIGATE THE EFFECTIVENESS OF FILMED CHEMISTRY AND PHYSICS COURSES. CONTROL VARIABLES WERE USED TO INSURE COMPARABILITY OF EXPERIMENTAL AND CONTROL GROUPS. ACHIEVEMENT, INTEREST, AND ATTITUDE SERVED AS THE STANDARDS BY WHICH THE EFFECTIVENESS OF THE FILMED COURSES WERE JUDGED. BOTH GROUPS WERE PRE- AND POST-TESTED AND THE RESULTS ANALYZED. RESULTS INDICATED THAT (1) THE CHEMISTRY FILMS WERE AS EFFECTIVE AS THE CONVENTIONAL TEACHING BUT THE PHYSICS FILMS WERE NOT AND (2) THE FILM AND NON-FILM APPROACHES FOSTER COMPARABLE STUDENT INTEREST IN PHYSICAL SCIENCE. THE INVESTIGATORS CAUTIONED THAT SOME LIMITATIONS OF THE STUDY MADE IT UNWISE TO DRAW FIRM CONCLUSIONS FROM THE RESULTS OBTAINED. (AL)

ED003549

TITLE VA 091

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated do not necessarily represent official Office of Education position or policy.

THE EFFECTIVENESS OF FILMED SCIENCE COURSES IN PUBLIC SECONDARY SCHOOLS

W. JAMES POPHAM
JOSEPH M. SADNAVITCH

DEPARTMENT OF EDUCATION AND PSYCHOLOGY
KANSAS STATE COLLEGE OF PITTSBURG

PREPARED UNDER PROVISIONS OF A RESEARCH GRANT
U.S. OFFICE OF EDUCATION
DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
WILLIAM A. BLACK, PROJECT DIRECTOR

AUGUST, 1960

THE EFFECTIVENESS OF FILMED SCIENCE COURSES IN PUBLIC SECONDARY SCHOOLS

W. James Popham

Joseph M. Sadnavitch

Department of Education and Psychology

Kansas State College of Pittsburg

Prepared Under Provisions of a Research Grant
U.S. Office of Education
Department of Health, Education, and Welfare

William A. Black, Project Director

August, 1960

Acknowledgements

The science films evaluation project reported in the following pages could not have been completed without the cooperation of many individuals. Prominent among these were administrators and science teachers of the twelve Kansas secondary schools which participated in the research project. To those administrators and to the following teachers who used the filmed courses in their teaching, sincere appreciation is extended: A. Frank Barone, Girard High School; George D. Caldwell, Iola High School; Wendell E. Ferguson, Independence High School; Russell A. Kern, Sr., Chanute High School; William R. Lynn, Field Kindley High School, Coffeyville; Robert W. McGee, Independence High School; Leonard N. McGuire, Cherokee County Rural High School; Henry T. Norris, Neodesha High School; Calvin L. Pearman, Ft. Scott High School; Roger A. Pruitt, Labette County Community High School; Robert K. Smith, Parsons High School; Max Struble, Pittsburg Senior High School; Dempsey Walker, Baxter Springs High School.

W.J.P.

J.M.S.

TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION	1
	Previous Research	1
	Background of the Experiment	7
	Organization of the Report	7
II.	METHODOLOGY	9
	The Variables	9
	The Measures	10
	Research Sample	13
	Procedure	14
	Analysis of the Data	18
III.	RESULTS - PHYSICS	21
	Achievement	21
	Interest in Physical Science	28
	Attitude Toward Physics as a School Subject	31
	Summary of Physics Results	34
IV.	RESULTS - CHEMISTRY	35
	Achievement	35
	Interest in Physical Science	40
	Attitude Toward Chemistry as a School Subject	43
	Summary of Chemistry Results	46
V.	DISCUSSION	47
VI.	END-OF-COURSE REACTIONS TOWARD FILMS	51
	Student Opinions	51
	Questionnaire Responses	51
	Questionnaire Responses of Ability Level Groups	52
	Strengths, Weaknesses, and Suggestions for Improvement	56
	Teacher Opinions	58
	Students' Attitudes Toward Filmed Courses	59
	Accuracy of Grade Estimation	61
	REFERENCES	63
	APPENDIX	64

LIST OF TABLES

Table — Page

1. Intercorrelations Between Measures Employed in the Achievement Analyses for 247 Physics Students 22

2. Analysis of Covariance of Experimental and Control Physics Students' Achievement Performance 22

3. Physics Students' Criterion and Control Variable Means. 23

4. Analysis of Covariance of Achievement Performance for Experimental and Control Physics Students Representing Three Ability Levels. 25

5. Means of Experimental and Control Physics Students (Classified by Ability) for Pre- and Post-experiment Achievement Scores, Intelligence Scores and Grade Point Averages. 26

6. Unadjusted and Adjusted Post-experiment Achievement Means for Experimental and Control Physics Students Included in the Multiple Analysis of Covariance 27

7. Unadjusted and Adjusted Post-experiment Achievement Means for Physics Ability Groups Included in the Multiple Analysis of Covariance. 27

8. Significance of Differences Between Interest Score Changes for Experimental and Control Physics Students Classified as a Total Group and in Ability Level Groups 29

9. Significance of Differences Between Experimental Physics Students' Pre- and Post-experiment Physical Science Interest Scores. 30

10. Significance of Differences Between Control Physics Students' Pre- and Post-experiment Physical Science Interest Scores . . 30

11. Significance of Differences Between Attitude Scores for Experimental and Control Physics Students Classified as a Total Group and in Ability Level Groups 31

12. Significance of Differences Between Experimental Students' Pre- and Post-experiment Attitudes Toward Physics as a School Subject. 33

13. Significance of Differences Between Control Students' Pre- and Post-experiment Attitudes Toward Physics as a School Subject. 33

14. Intercorrelations Between Measures Employed in the Achievement Analyses for 446 Chemistry Students 36

Table

		Page
15.	Analysis of Covariance of Experimental and Control Chemistry Students' Achievement Performance	36
16.	Chemistry Students' Criterion and Control Variable Means. . .	37
17.	Analysis of Covariance of Achievement Performance for Experimental and Control Chemistry Students Classified by Ability	38
18.	Means of Experimental and Control Chemistry Students (Classified by Ability) for Pre- and Post-experiment Achievement Scores, Intelligence Scores, and Grade Point Averages.	39
19.	Unadjusted and Adjusted Post-experiment Achievement Means for Experimental and Control Chemistry Students Included in the Multiple Analysis of Covariance	40
20.	Unadjusted and Adjusted Post-experiment Achievement Means for Chemistry Students Classified by Ability and Included in the Multiple Analysis of Covariance	40
21.	Significance of Differences Between Interest Score Changes for Experimental and Control Students Classified as a Total Group and in Ability Level Groups	41
22.	Significance of Differences Between Experimental Chemistry Students' Pre- and Post-experiment Physical Science Interest Scores	43
23.	Significance of Differences Between Control Chemistry Students' Pre- and Post-experiment Physical Science Interest Scores .	43
24.	Significance of Differences Between Attitude Scores for Experimental and Control Chemistry Students Classified as a Total Group and in Ability Level Groups	44
25.	Significance of Differences Between Experimental Chemistry Students' Pre- and Post-experiment Attitudes Toward Chemistry as a School Subject	45
26.	Significance of Differences Between Control Chemistry Students' Pre- and Post-experiment Attitudes Toward Chemistry as a School Subject	45
27.	Chi Square Values for Responses of Experimental Physics Students Classified by Ability to Nine Questionnaire Items.	53
28.	Chi Square Values for Responses of Experimental Chemistry Students Classified by Ability to Nine Questionnaire Items.	55

Table | Page

29. Grade Estimation Accuracy of Experimental and Control Physics Students 61

30. Grade Estimation Accuracy of Experimental and Control Chemistry Students 62

CHAPTER I*

INTRODUCTION

One of the most widely acclaimed attempts to deal with a crucial educational problem through the utilization of mass media instructional materials has been the preparation of completely filmed courses in high school science subjects. The first of these courses, a series of 162 lectures and demonstrations conducted by Professor Harvey White, was produced during the 1956-57 academic year. The second course, developed during 1958-59, features a series of 160 lectures and demonstrations conducted by Professor John Baxter. Both film series were financed by the Fund for the Advancement of Education for distribution by Encyclopaedia Britannica Films, Inc. Because of the recency of their development, little research evidence regarding the effectiveness of the films has been reported. The present report describes an experiment designed to evaluate the filmed physics and chemistry courses in public secondary schools of southeast Kansas.

Previous Research

Four studies have been reported which center upon the effectiveness of the filmed physics series. At this writing the authors have been unable to discover any published research dealing with the filmed chemistry series.

The Wisconsin Physics Film Evaluation Project. The first major research evaluation of the filmed physics series was conducted by the

---

*The research reported herein was supported by a grant from the United States Office of Education, Department of Health, Education, and Welfare.

University of Wisconsin during the first semester of the 1957-58 academic year. This study assessed the effectiveness of the first half of the 162 films in thirty experimental and thirty control schools. At the end of an experimental period (90 days) 52 schools known as the control-control group were included in the experiment. Physics students in control-control schools were tested only at the end of the experimental period and until that time were not aware that they were to be included in the study.

During the experimental period, each school using the physics films viewed one film per day and used specially prepared lesson outlines. Any remaining class time was utilized by the teacher as desired. Control schools, although aware that they were involved in the research, did not use the physics films; physics was taught conventionally.

Among the most significant results of this investigation were the following:

1. When the performance of control groups and experimental groups was contrasted, no significant difference in achievement was evidenced.

2. When the performance of control groups, experimental groups, and control-control groups was contrasted, the control groups were significantly superior to both the experimental and the control-control groups in achievement. (Addition of the control-control groups introduced a degree of precision which resulted in significant differences.)

3. The control group evidenced significantly greater retention of physics information after a period of three months than did the experimental group.

4. The experimental group showed a significantly higher achievement level than the control groups when tested on information that was included in the films. (This result was based, however, upon only twenty-five test items which measured information found in the film units on mechanics, heat, and properties of matter.)

5. Teacher preparation (number of college level academic physics credits) was reflected in the achievement of students, up to a certain point (18 credits). Above that point, the study showed

no significant relationship between teacher preparation and student achievement.

6. Control students expressed a higher interest in science than did the experimental students.

It should be observed that the Wisconsin evaluation project dealt with only the first half of the physics series and, therefore, does not represent an evaluation of the entire filmed course. The use of one-half of the films can serve as a satisfactory representation of the value of the remaining films only if the latter half of the film series is comparable to the first. One might speculate that since the films were produced in connection with a "live" televised class featuring Professor White as the instructor, the technique of the instructor might improve as the semester proceeds. On the other hand, such factors as instructor fatigue might have lowered the quality of the latter half of the series. At any rate, one would be unjustified in assuming that an evaluation of only the first half of the films represents an adequate assessment of the value of the series in its entirety.

The SRA Study. During the second semester of the 1957-58 academic year, a study of the physics series was conducted by Science Research Associates, Inc. for Encyclopaedia Britannica Films, Inc. The results of this investigation have not been published, but are contained in a confidential report submitted to Encyclopaedia Britannica Films, Inc. by SRA. This document was made available to the present writers, but a request for permission to describe the results of that investigation in the present report was refused by officials of Encyclopaedia Britannica Films, Inc.[1]

---

[1]Personal communication to the writers from sales promotion manager, Encyclopaedia Britannica Films, Inc., July 15, 1960.

The Utah Project. The first test of the physics films over a full year period was conducted in the state of Utah in a project (Noall and Winget, 1959) sponsored by the Fund for the Advancement of Education. Twenty schools (ten control and ten experimental) were involved in this study. Each of the groups was constituted by several large, medium-sized, and small schools.

Because of large inter-school differences in mathematics and physics knowledge, study habits, intelligence, and interests, the Utah researchers abandoned the use of inferential statistical procedures in favor of gross non-inferential comparisons. These gross comparisons were supplemented with inferential statistics only on selected groups.

Gross comparisons revealed comparable gains for the film and non-film groups, particularly when group differences in intellectual aptitudes were considered.

The original student sample was approximately 500. The statistical analyses reported in this investigation generally concerned significantly smaller proportions of the original sample. For example, one analysis revealed that in medium-sized schools, students who were taught by regular instructional methods made significantly greater gains than did those taught with films. This analysis involved 66 subjects. On the basis of other analyses involving as few as 17 subjects, the conclusion was drawn that in small and large schools, the difference in achievement between film and non-film groups was not statistically significant.

In another analysis dealing with only 35 subjects, a comparison of differences in achievement gains was made between a combined group of high and low ability students versus middle ability students. This comparison revealed no significant differences. The high and low ability students were

combined because results of a previous research investigation had suggested that students in the middle intellectual ability group benefitted more from film instruction than did students in either extreme.

Although the researchers report that the study was designed to assess attitudinal progress, no information regarding attitude changes of experimental and control groups was reported.

On the basis of the description of the research, one is hesitant to draw conclusions from the Utah investigation. It is unfortunate that appropriate statistical procedures were not employed in order to compensate for the initial differences between the groups. Since such adjustments were not made, however, results of the research are difficult to interpret.

The University of Kansas Investigation. A second attempt (Anderson and Montgomery, 1959) to evaluate the physics film series on a full year basis was conducted by the University of Kansas during the 1958-59 academic year. This investigation involved the use of two large high schools in the same school district. One of the schools, with nine physics classes (225 pupils) and two teachers, served as the experimental school. The second school, with seven physics classes (176 pupils) and two teachers, served as the control school.

Both experimental and control groups used the same textbook and work-book. In the control classes, two days a week were devoted to lectures, discussion, and demonstrations. Two days a week were devoted to laboratory experiments. One day was devoted to testing and discussion of the tests. In the experimental classes, one film per day was shown and the remaining time was used for class discussion.

In the initial analysis, statistical procedures were employed to equate the two groups with respect to intelligence and pre-test scores.

The results of the analysis revealed no significant difference in end-of-course achievement between the film and non-film groups.

As the investigators point out "Since a comparison of the two groups in Analysis I did not yield significant results, attempts were made to locate significant results by other methods." (p. 388) A second analysis was reported which divided the film and non-film groups into three sub-groups according to intelligence levels. Experimental and control groups, when divided into high, average, and low intellectual ability groups, were also not significantly different.

In a third analysis, tests were made of the difference between pre-test and post-test variance for both experimental classes and control classes. None of the differences in variance for the control classes were significant, but four of the nine experimental classes revealed a significantly greater post-test than pre-test variability.

On the assumption that greater variation in classroom achievement is evidence of the release of individual differences among pupils during the learning process, the researchers observed (italics in original) "Thus one must conclude that the film method produced somewhat superior results than the conventional method of teaching physics." (p. 390)

In the view of the present writers, the emphasis upon the above conclusion seems to be based on an assumption[2] which is somewhat tenuous at best. It must be recalled that all mean difference tests yielded non-significant results.

---

[2]For an elaboration of this assumption see Lucow, William H., The use of analysis of variance in estimating the components of variation in an experimental study of learning. Unpublished Doctoral Dissertation, University of Minnesota, 1953, (pp. 120-121).

Background of the Experiment

During the 1959-60 academic year, an experiment designed to evaluate both physics and chemistry film series was conducted by Kansas State College of Pittsburg. The phase of the project dealing with the physics series was conceived of primarily as a corroborative effort, that is, an attempt to add research evidence to that which had already been reported regarding the physics series. The segment of the research dealing with the chemistry series represented one of the initial efforts to evaluate the filmed chemistry course. Since many facets of the two phases of the investigation were common, it was decided to combine the two investigations into a single research project.

The stimulus to conduct the experiment was provided by the establishment of a research grant program sponsored by the United States Office of Education, Department of Health, Education, and Welfare, under provisions of Title VII of the National Defense Education Act of 1958.

Organization of the Report

A brief description of the remainder of the report can be given at this point. In the second chapter, the methodological details of both sub-investigations of the project (i.e., physics and chemistry) will be treated. Since many features of one sub-investigation were common to the other, the methodology of both will be treated as one. In the methodology chapter the variables under consideration, their measurement, the research sample represented in the investigation, the procedure followed during the course of the experiment, and the techniques employed in the analysis of the data will be discussed. In the third chapter, major results of the physics evaluation will be reported. The fourth chapter will deal

with major results of the chemistry evaluation. The fifth chapter will include a general discussion of the major results of both sub-investigations. A final chapter will describe the reactions toward the films of participating students and teachers.

CHAPTER II

METHODOLOGY

The Variables

The variables considered in the present research project can be categorized readily according to whether they were treated as criterion or control variables. Criterion variables served as the standards by which the effectiveness of the filmed courses was judged. Control or equating variables were used to insure comparability of experimental and control groups.

Criterion Variables. The major criterion variable under consideration in the experiment was student subject matter achievement. Since the science films purport to enable the high school student to be taught effectively via film, the efficiency of the filmed approach was assessed in terms of subject matter achievement.

The second criterion variable to be considered was a student's interest in the general area of the physical sciences. This too was considered to represent an important element affecting student progress in a high school learning situation. For even though student achievement gains under Method "A" might be superior to achievement gains under Method "B", if the student's interest in the subject field is stultified by Method "A", then we might justifiably assert that the "superior" approach was not totally beneficial.

The third criterion variable studied was the attitude of the student toward the school subject itself. In order that the films can be judged optimally effective, it should be demonstrated that the attitudes toward the subject matter which they engender should be comparable, at least, with those attitudes toward the subject matter developed by students who have been taught in a conventional manner.

Control Variables. Certain variables were employed for control purposes. That is, they were used to assure comparability of the experimental and control groups involved in the experiment.

When end-of-course achievement was used as a criterion variable, groups were equated statistically with respect to the following control variables: pre-experiment achievement, previous scholastic performance, and intellectual aptitude.

When end-of-course interest in the general area of physical science was used as a criterion variable, students' pre-experiment interest in physical science served as the control variable.

When end-of-course attitude toward the school subject was used as a criterion variable, students' pre-experiment attitude toward the school subject served as the control variable.

The Measures

Measures of student achievement in the investigation were obtained through the use of the Cooperative Physics Test[3] and Cooperative Chemistry Test[4].

The Cooperative Physics Test is available in two forms, Form Y and Form Z, each consisting of seventy-seven items of the multiple choice type. The test is divided into two parts with 20 minutes alloted for each. The instrument is designed to measure the extent to which students have achieved the major objectives of a high school physics course.

The Cooperative Chemistry Test is available in three forms, Form X,

---

[3] Cooperative Physics Test, Educational Testing Service, Princeton, New Jersey, 1950.

[4] Cooperative Chemistry Test, Educational Testing Service, Princeton, New Jersey, 1950.

Form Y, and Form Z. The forty minute test, composed of multiple choice items, is divided into two parts with 25 minutes allowed for Part I (52-54 items) and fifteen minutes for Part II (27-29 items). The test is designed to assess student attainment of the principal objectives of a high school chemistry course.

Student interest in the general area of physical science was assessed through use of the Physical Science sub-scale of the Thurstone Interest Schedule.[5] This instrument consists of 100 pairs of occupational titles. The task required of the person completing the schedule is to indicate his preference regarding the occupational titles in each pair. Every occupational title is related to one of ten occupational interest areas which are revealed in ten sub-scale scores.

Student attitude toward a particular course was measured by the use of A Scale For Measuring Attitude Toward Any School Subject.[6] This instrument is available in two forms, A and B. Although developed in 1934, it still appears to retain its unique usefulness for measuring attitude toward a school subject (Clark, 1959, p. 92). The scale consists of 45 statements arranged in a continuum from those which are extremely favorable ("No matter what happens, this subject always comes first.") to those which are extremely unfavorable statements ("I hate this subject."). A student is instructed to mark any of the 45 statements with which he agrees. A median scale value is used to reflect the students's position on the continuum.

Intellectual aptitude was assessed by the Otis Quick-Scoring Mental

---

[5] Thurstone Interest Schedule, The Psychological Corporation, New York, 1947.

[6] A Scale For Measuring Attitude Toward Any School Subject, Purdue Research Foundation, Purdue University, 1934.

Ability Test.[7] The Gamma version of this instrument (Form C) was employed in the study. This test consists of 80 items designed to assess intelligence. A period of 30 minutes working time is allowed for completion of the test.

Student attitude toward the film courses (in general, not a particular filmed course) was assessed by the Attitude Toward Film Courses Scale[8] which was especially designed for the present project. This Likert-type scale consisted of 30 items selected from a pool of 100 items which were reviewed by 16 judges (faculty members and advanced graduate students). The judgments served to identify the most appropriate items relative to item favorability or unfavorability. Students who were being taught via film were asked to indicate strong agreement, agreement, uncertainty, disagreement, or strong disagreement with each of the 30 statements included in the scale. Items were scored by assigning a value of four points to the response most favorable toward filmed courses, three points to the next most favorable response, and so on to a zero for the least favorable response.

The index of past student scholastic performance utilized in the present experiment was student cumulative high school grade point average. All grade point averages were converted to a four point system, i.e., "A" equals 4.00, etc.

End-of-course student opinions were assessed through the use of a questionnaire constructed for the present study. Students were asked a number of questions regarding such matters as study habits, grade expected,

---

[7] Otis Quick-Scoring Mental Ability Tests, World Book Co., Yonkers-on-Hudson, New York, 1939.

[8] A copy of this scale is included in the appendix.

etc. Those students taking science courses by film were asked additional questions concerning their reactions to the films. In order to facilitate tabulation, questions were of a multiple choice type, so that students could indicate their response by a number rather than by a written statement.

Teacher reaction was obtained through use of a specially prepared questionnaire concerning the films. In part, the questionnaire was adapted from the Teacher Reaction Survey questionnaire[9] prepared by the American Institute of Physics. The latter instrument was used in an evaluation of physics instruction by film and television in a research project supported by the Fund for the Advancement of Education.

Research Sample

The research sample was drawn from students enrolled in twelve southeast Kansas secondary schools offering both physics and chemistry. All schools were located sufficiently close to the college conducting the investigation to facilitate practicable distribution of films. At the outset, over 40 high schools were considered as potential participants in the research project. From these, twelve schools were selected for inclusion in the experiment. During July, 1959, administrators and teachers from the twelve schools were invited to Kansas State College of Pittsburg in order that they might hear a description of the research project and indicate their decision regarding participation in the study. Representatives from Encyclopaedia Britannica Films, Inc. were present to describe the chemistry and physics film series. Members of the college research staff described the forthcoming experiment. All twelve schools agreed to participate in the study.

---

[9] Teacher Reaction Survey, American Institute of Physics, New York.

The twelve secondary schools were divided into two groups, six schools to serve as experimental for physics (taught by the film series) and control for chemistry (conventional chemistry instruction), and six to serve as experimental for chemistry (taught by the film series) and control for physics (conventional physics instruction). Schools in the two groups were matched according to the following factors: grade organization (6-3-3, 6-2-4, 6-4-4), student enrollment, assessed property valuation, community population, type of accreditiation, and number of full time faculty members. This matching procedure was undertaken prior to the assignment of schools to groups.

From these twelve schools all students who were enrolled in either physics or chemistry were used as subjects. Of these, 312 physics students, 155 of whom were to be taught via film, and 475 chemistry students, 234 of whom were to be taught via film, were included in the original sample.

Procedure

Chemistry teachers in the six high schools that would be employing the chemistry film series participated in a one day workshop on the college campus prior to the beginning of school. The purpose of this workshop was to determine classroom procedures to be utilized during the experiment and to arrange for a film distribution schedule. On the following day, a similar workshop was staged with physics teachers from the six schools that would be using the physics films.

It was agreed following these discussions that, rather than employing a rigid experimental and, perhaps, somewhat artificial classroom procedure throughout the course of the experiment, teachers would be allowed to employ the films as they wished, within certain limits. Among these

limitations were (1) that at most one film (lasting approximately 30 minutes) per day was to be employed, and (2) that a minimum number of films per week were to be used. For the chemistry series, it was agreed that four films per week should be shown, thereby leaving one day per week available for laboratory purposes. For physics it was agreed that four films be shown every other week with five films to be shown on alternate weeks. The teachers were allowed to retain the textbooks that they ordinarily used in connection with their courses.

It was unanimously agreed by the teachers that there would need to be at least some time devoted to laboratory and discussion periods in these courses, and certain films needed to be deleted from the series. The necessary number of films was removed from each series on the basis of participating teachers' preferences during the pre-school workshops. Each film was considered separately. After examining a printed description of the film's contents, teachers agreed to retain or delete each film. Thirteen films were deleted from the physics series and 28 films from the chemistry series. A total of 149 physics and 132 chemistry films were to be shown during the academic year. As the study progressed, it became evident that differences in school opening and closing dates would cause these estimates to be altered slightly. Four physics schools received 149 films, one received 148 films, and one received 147 films. One chemistry school received 132 films, three received 131 films, and two received 130 films. In both series all but a few films were in black and white, rather than color.

Since only one set of each film series was available, a distribution scheme involving "staggered" units was employed. The distribution scheme adopted with each series was essentially that developed by the producers

of the films for use in distributing films to six schools.[10]

During the first seven days of the school term, members of the research staff administered the following instruments to all subjects: the Cooperative Physics Test, Form Y (or the Cooperative Chemistry Test, Form Y); the Thurstone Interest Schedule; the Otis Quick-Scoring Mental Ability Test; and A Scale For Measuring Attitude Toward Any School Subject, Form A. For each school it was necessary to use two full periods per class in the administration of these materials.

The initial films of the physics and chemistry series were distributed during the first week of school. According to the schedule developed at the pre-school workshops, films were delivered by automobile every week-end (other than vacations) throughout the school year. Experimental chemistry schools received four films each weekend. Experimental physics schools received four films one weekend and five films the next.

During the course of the academic year, members of the research staff visited participating schools in order to supervise the utilization of the films or to assist with problems associated with the research project. It was suggested by some of the participating teachers that a workshop be arranged in order that they might share their problems regarding film utilization and, perhaps, solutions to those problems with other participating teachers. Accordingly, a workshop was scheduled for late October. Seven teachers participated in this workshop. Duplicated summaries of the workshop discussions were distributed to all teachers participating in the project. At the workshop, results of students' pre-test scores were distributed to each teacher. An interpretation sheet concerning the test results was also supplied. For those teachers who did

---

[10]Copies of these disbribution plans may be obtained from Encyclopaedia Britannica Films, Inc.

not attend the meeting, pre-test scores and interpretation sheets were distributed by mail.

The next stage of the data-gathering phase of the investigation concerned students' grade point averages. The averages were to be used as an index of previous academic performance. Letters were sent to participating high schools suggesting the grade point averages either be computed by the local high school personnel or by a visiting member of the research staff. Eleven schools returned the grade point information. In one school, members of the research staff compiled the information.

Prior to the initiation of the post-experiment testing phase of the project, two questionnaires were developed, one for students (experimental as well as control) and one for the participating teachers. These were designed to assess reactions toward the utilization of films in science courses. Approximately two weeks before the end of the school year, the student questionnaires were mailed to participating teachers who distributed them to students and returned the completed questionnaires by mail to the college research staff. Teacher questionnaires were distributed during the post-experiment examinations and were returned by mail.

During the month of March, participating schools were contacted in order to plan post-testing dates which would be coordinated with the schools' final examination schedules. All post-experiment examinations were administered between April 28 and May 23. The final film delivery took place during the third week in May.

The following post-tests were administered during the final week of each school's academic year: the Cooperative Physics Test, Form Z (or the Cooperative Chemistry Test, Form Z); the Thurstone Interest Schedule; A Scale For Measuring Attitude Toward Any School Subject, Form B; and the Attitude Toward Film Courses Scale. Additional data secured after the post-

experiment testing sessions included the final grade assignments made by participating instructors.

Analysis of the Data

Tests were scored, results tabulated, and data analyzed during the months of June and July, 1960. A brief explanation of the statistical tests employed in the analysis will follow.

The analysis of covariance statistical technique was employed to test differences between film and non-film groups with respect to subject matter achievement. This procedure allows for the statistical equalization of experimental and control groups on measures which are considered to be relevant to the criterion variable. In the analyses of post-experiment achievement, measures considered relevant for control purposes were students' scores on the pre-experiment achievement test, students' grade point averages, and students' scores on the intelligence test.

For analyses involving data secured through administration of the interest schedule, the attitude scales, and the questionnaires, non-parametric statistical tests were employed. These data were measured on scales which were considered inappropriate for the application of parametric statistical procedures.

In the case of the attitude and interest data, gain scores between the experimental and control groups were contrasted by the use of the Mann-Whitney U Test.[11] This test is a powerful alternative to the parametric t test and serves the function of testing differences between two independent groups. It is not necessary to meet the restrictive assumptions

---

[11] For a discussion of the function and method of the Mann-Whitney test see Siegel, Sidney; Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill Book Co., Inc., New York, 1956, (pp. 116-127).

(interval data) associated with the t test in order to employ the Mann-Whitney Test.

When testing for differences between students' pre-experiment and post-experiment scores on attitude and interest data, the sign test[12] was employed. This test is appropriate for assessing differences between two sets of scores for the same group. This test, although less powerful than a t test for related samples, can be appropriately employed with ordinal data such as those yielded by the interest and attitude instruments.

Differences between groups with respect to responses to questionnaire items were assessed through the use of the chi square test.[13] This test is appropriate for assessing differences between independent samples on data which can be considered nominal rather than interval.

Intercorrelation coefficients were computed among the following variables: post-experiment achievement, pre-experiment achievement, intelligence test scores, and grade point averages. These relationships were determined in order to assess the appropriateness of employing the measures as controls in the covariance analyses.

In general, the analysis scheme for both physics and chemistry involved assessment of the differences between experimental and control groups on the several criterion measures employed. Differences were also assessed between students representing three intelligence levels in the experimental and control groups. The analyses involving separate intelligence levels were undertaken in order to test the assumption that filmed instructional approaches may prove more effective for certain segments of

---

[12]For a discussion of the function and method of the sign test see Siegel, op. cit., (pp.68-75).

[13]For a discussion of the function and method of the chi square test for independent samples, see Siegel, op. cit., (pp. 104-111 and 175-179).

the student population than for the entire range of ability levels. Several investigators have suggested this possibility (Engelhart, Schwachtgen, & Nee, 1958; Noall & Winget, 1959). Both experimental and control groups were divided into approximately equal thirds according to students' scores on the Otis intelligence test.

In the statistical analysis of the results, only those students for whom requisite test scores were available are included in each analysis. This will, of course, result in a varying number of students involved in the different analyses. The actual number of students involved in each analysis will be reported along with results of the statistical tests.

CHAPTER III

RESULTS - PHYSICS

The analysis of physics group differences on the major criterion variables of achievement, interest, and attitude are reported in this chapter. In each section, differences between total experimental and control groups are reported as well as differences between experimental and control students classified into three ability level groups.

Achievement

Total Group Differences. Difference in achievement between experimental and control groups was tested for significance by the analysis of covariance procedure.. This technique makes it possible to statistically equate the experimental and control groups on measures which are considered to be relevant to the criterion measure. The measures upon which the groups were statistically equalized were initial knowledge of physics (pre-experiment achievement), intellectual aptitude (Otis intelligence test), and previous scholastic performance (grade point average). The criterion measure of achievement was students' performance on an examination administered at the close of the experiment. The measures used to assess these variables are described in the second chapter of this report.

Intercorrelations. Intercorrelations between all measures employed in the achievement analyses were computed. These coefficients are presented in Table 1. The relationship of the criterion achievement variable to the three control variables, i.e., pre-achievement (r=.68), intelligence (r=.51), and grade point average (r=.30), indicates the appropriateness of employing these variables for control purposes.

Table 1

Intercorrelations between measures employed in the achievement analyses for 247 physics students

	Variable	2	3	4
1	Post-experiment Achievement	.68	.51	.30
2	Pre-experiment Achievement		.48	.69
3	Intelligence			.51
4	Grade Point Average			

Having adjusted for initial differences between the experimental and control groups, the analysis of covariance revealed that the performance of the control group was significantly better than that of the experimental group. The difference was statistically significant beyond the .001 level. The analysis of covariance for achievement performance of experimental and control students is presented in Table 2.

Table 2

Analysis of covariance of experimental and control physics students' achievement performance

Source of Variation	Residuals			F
	Degrees of Freedom	Sum of Squares	Mean Square	
Between	1	936.465	936.465	14.839***
Within	242	15,272.671	63.110	
Total	243	16,209.136		

***Significant beyond the .001 level.

In Table 3 the criterion and control variable means associated with this analysis are presented. It can be seen that the control group mean, after adjustment for initial between-group differences, is 60.15 on the final post-experiment achievement test, whereas the experimental mean, after adjustment for initial differences, is 55.78.

Table 3

Physics students' criterion and control variable means

Group	N	Criterion		Control		
		Post-achievement Adjusted	Unadjusted	Pre-test Achievement	IQ	GPA
Experimental	135	55.78	56.43	47.22	116.77	2.92
Control	112	60.15	59.29	48.77	112.96	2.99

An examination of the differences between the means of the two groups on the control variables will suggest why the mean adjustment actually intensifies the difference between the two groups. The initial difference in intelligence favored the experimental group, yet the control group's performance on the final examination exceeded that of the experimental group. In other words, on the variable of intelligence, the control group started with a disadvantage, but outperformed the experimental group. Therefore, the adjusted post-achievement means represent the difference between the two groups, as if the groups had been equal with respect to pre-experiment achievement, intelligence, and grade point averages.

Ability level group differences. Having determined that the academic performance of the control group was significantly better than the experimental group, the next analysis conducted tested the following hypotheses:

(1) that there was a significant differential in achievement between student groups of different intellectual ability levels and (2) that the performance of these ability level groups was related to the method of teaching, i.e., film versus non-film.

In order to test these hypotheses, a multiple analysis of covariance technique was applied in which three tests of significance were possible. First, it was possible to test the hypothesis that there was a difference in achievement between the experimental and control group. (This, of course, had been established previously by the single classification analysis of covariance.) The second hypothesis was that when students had been classified into three levels of intelligence (irrespective of whether they were members of the control or experimental group), differences in post-test achievement would exist. The third hypothesis concerned interaction of teaching method versus ability level. Since the latter hypothesis was considered most important, it was necessary to employ the multiple covariance analysis. The testing of interaction effects is available only through a multiple analysis of variance procedure (or its extension, multiple analysis of covariance). Once again the control variables employed were pre-experiment achievement, intelligence, and grade point average.

Both the experimental and the control groups were divided into equal thirds (high ability, average ability, low ability)[14] according to level of intellectual aptitude as measured by the Otis intelligence test.

---

[14]It should be noted that since students enrolled in physics classes generally possess superior intellectual ability, the terms "high", "average", and "low" must be interpreted only within the framework of the present study. The Otis IQ ranges for the three experimental groups were: high, 133-122; average, 121-114; low 113-91. For the three control groups the ranges were: high, 131-120; average, 119-109; low, 108-90.

In this analysis, it was necessary to delete scores of 25 students in order to achieve equal subgroups for the analysis of covariance. This step was taken in order to avoid the necessity of correcting for disproportionality between subgroups.[15] Twenty-four subjects were randomly deleted from the experimental group and one subject was eliminated from the control group.

In Table 4 the multiple analysis of covariance results for the three sources of variation are presented. It can be seen that a significant difference was again found between the experimental and control groups. Significant differences were also observed between the three ability groups. There was no significant interaction of teaching method and ability level.

Table 4

Analysis of covariance of achievement performance for experimental and control physics students representing three ability levels

Source of Variation	Residuals			F
	Degrees of Freedom	Sum of Squares	Mean Square	
Method	1	701.040	701.040	29.115***
Ability Level	2	238.094	119.047	4.944**
Interaction	2	45.110	22.555	.937
Within	213	5128.747	24.079	

***Significant beyond the .001 level.

** Significant beyond the .01 level.

[15]Although adjustment of disproportionate subclass frequencies in the analysis of covariance procedure can be made, it is an extremely time-consuming process. The mathematical demonstration of the procedure has been treated by Yates. (Fei Yates, General solution of the analysis of variance and covariance in the case of unequal and disproportionate numbers of observations in the subclasses. Psychometrika, 11:107-120, 1946)

In Table 5 the means for the experimental and control students included in the multiple analysis of covariance are presented for post-experiment achievement, pre-experiment achievement, intelligence, and grade point averages.

Table 5

Means of experimental and control physics students (classified by ability) for pre- and post-experiment achievement scores intelligence scores and grade point averages

Group		N	Criterion	Control		
			Post-Achievement	Pre-Achievement	IQ	GPA
Experimental	High	37	61.22	52.95	127.16	3.34
	Average	37	58.19	49.81	117.81	3.02
	Low	37	51.19	38.73	105.60	2.42
Control	High	37	63.73	52.95	125.30	3.26
	Average	37	60.95	49.03	113.22	2.97
	Low	37	53.41	44.62	100.62	2.75

In order to compensate for initial differences between groups on the control variables, adjusted means were computed for method groups (experimental and control) and for ability groups (high, average, low). The unadjusted and adjusted post-experiment achievement means for method are presented in Table 6. The slight differences between these method group means and the means reported in the single analysis of covariance are accounted for by the random deletion of scores of 25 students. The unadjusted and adjusted post-experiment achievement means for ability groups are presented in Table 7.

Table 6

Unadjusted and adjusted post-experiment achievement means for experimental and control physics students included in the multiple analysis of covariance

Group	N	Unadjusted Mean	Adjusted Mean
Experimental	111	56.86	56.24
Control	111	59.36	59.98

Table 7

Unadjusted and adjusted post-experiment achievement means for physics ability groups included in the multiple analysis of covariance

Group	N	Unadjusted Mean	Adjusted Mean
High Ability	74	62.47	54.71
Average Ability	74	59.57	58.33
Low Ability	74	52.30	61.30

An interpretation of the shift in direction of the adjusted post-achievement means for the three ability groups should be given at this point. It can be observed from Table 7 that although the actual (unadjusted) post-experiment performance of the high ability group exceeds the performance of both the average and low groups, the high ability is inferior to the other groups when adjustments are made for the initial group differences in pre-experiment achievement, intelligence, and grade point average. This phenomenon should be expected in most studies contrasting performance of ability level groups over an extended period of time, especially where a

number of control variables are employed. What is actually reflected in the reversal resulting from the adjustment is the difficult nature of the task imposed upon the high ability group in expecting a continuation of their relative pre-experiment superiority over the low group throughout the course of a year-long study. As measurement experts will testify, the difficulty of achieving at the upper end of a measurement scale is considerably greater than the difficulty associated with advancing at the lower end or middle of a scale.

Interest in Physical Science

Differences between pre- and post-experiment physical science interest shifts of the experimental and control groups (both for the total groups and for ability level groups) were assessed by the Mann-Whitney U Test. This technique, of particular utility with extremely small samples, can be employed with large samples such as those involved in the present experiment by a conversion process which yields a z value interpretable from a normal curve table.

Differences between groups. The significance tests for differences between experimental and control group interest changes from pre-experiment to post-experiment, as measured by the physical science sub-scale of the Thurstone schedule, revealed no significant differences between the groups considered as a whole or by separate ability levels. The z values yielded from the Mann-Whitney U Test, as well as the group favored by the difference, are presented in Table 8.

Table 8

Significance of differences between interest score changes for experimental and control physics students classified as a total group and in ability level groups

Group	N*	Mann-Whitney Test z value	Group favored by difference
Total			
Experimental	141		
Control	149	.330	experimental
High Ability			
Experimental	42		
Control	38	.520	control
Average Ability			
Experimental	45		
Control	39	.215	experimental
Low Ability			
Experimental	54		
Control	40	1.139	experimental

*The difference between the total sample and the sum of the subgroup samples is explained by the fact that students for whom no intelligence scores were available could not be assigned to separate ability groups, but were included in the total analysis.

Pre- and post-experiment changes. In general, there was a tendency for both experimental and control groups to manifest a reduced interest in physical science at the end of the experiment in comparison with the interest they indicated at the beginning of the experiment. Only one of these comparisons was significant, namely, the loss in interest evidenced by the experimental students of average ability. This change was significant beyond the .05 level. The only gain observed was in the low ability experimental group. This gain, although not significant, was at variance with the direction of all other group interest shifts.

Sign tests of a significance for differences between experimental

students' pre- and post-experiment physical science interest scores are presented in Table 9. In Table 10 tests of significance for differences between control students' pre- and post-experiment physical science scores are presented.

Table 9

Significance of differences between experimental physics students' pre- and post-experiment physical science interest scores

Group	Sign Test z value	Direction of difference
Total	1.909	loss
High Ability	1.742	loss
Average Ability	2.006*	loss
Low Ability	.291	gain

*Significant beyond the .05 level.

Table 10

Significance of differences between control physics students' pre- and post-experiment physical science interest scores

Group	Sign Test z value	Direction of difference
Total	1.327	loss
High Ability	.530	loss
Average Ability	1.742	loss
Low Ability	1.237	loss

Attitude Toward Physics as a School Subject

Differences between groups. Differences between experimental and control students' pre- to post-experiment shifts in attitude toward physics as a school subject were analyzed by the Mann-Whitney U Test. The difference between changes in attitudes for the total groups favored the control group. That is, the experimental group's shift in attitude toward physics as a school subject was significantly more unfavorable than that of the control group. This difference was significant beyond the .05 level.

In Table 11, the results of tests of significance for differences between attitude scores of experimental and control physics groups, considered as total groups and in separate ability groups, are presented.

Table 11

Significance of differences between attitude scores for experimental and control physics students classified as a total group and in ability level groups

Group	N	Mann-Whitney Test z value	Group favored by difference
Total			
Experimental	117		
Control	132	2.185*	control
High Ability			
Experimental	34		
Control	36	2.421*	control
Average Ability			
Experimental	39		
Control	36	1.400	control
Low Ability			
Experimental	41		
Control	28	.257	control

*Significant beyond the .05 level.

When differences between experimental and control students were considered in terms of ability level groups, differences again favored the control groups, although only the difference between high ability experimental and control groups was significant. This difference was also significant beyond the .05 level.

Pre- and post-experiment changes. The differences between the pre- and post-experiment changes of students' attitudes toward physics as a school subject were considered separately for both experimental and for control groups. These differences, for the total group as well as for the ability level groups, were tested for significance by sign tests. Changes in attitude scores indicated that the experimental and control groups manifested significantly less favorable attitudes toward physics as a school subject at the conclusion of the experiment than at the beginning of the experiment. In all but one comparison (low ability control students), differences were significant beyond the .01 level. Significance test results for differences between experimental students' pre- and post-experiment attitudes toward physics as a school subject are presented in Table 12. Significance test results for differences between control students' pre- and post-experiment attitudes toward physics as a school subject are presented in Table 13.

Table 12

Significance of differences between experimental students' pre- and post-experiment attitudes toward physics as a school subject

Group	Sign Test z value	Direction of difference
Total	4.442**	loss
High Ability	3.710**	loss
Average Ability	3.846**	loss
Low Ability	3.125**	loss

**Significant beyond the .01 level.

Table 13

Significance of differences between control students' pre- and post-experiment attitudes toward physics as a school subject

Group	Sign Test z value	Direction of difference
Total	5.117**	loss
High Ability	2.787**	loss
Average Ability	3.041**	loss
Low Ability	1.333	loss

**Significant beyond the .01 level.

Summary of Physics Results

The principal results of the physics phase of the investigation can be summarized as follows:

1. The achievement performance of the control group was significantly better than that of the experimental group.

2. There was no significant interaction of teaching method and student ability level.

3. There were no significant differences in pre- and post-experimental physical science interest changes between the experimental and control groups.

4. Although both the experimental and the control groups evidenced a less favorable attitude toward physics (as a school subject) at the end of the study than they did at the beginning of the investigation, the attitudes of the experimental group were signficantly more unfavorable than those of the control group.

CHAPTER IV

RESULTS - CHEMISTRY

The results of the analyses concerning the major chemistry criterion variables of achievement, interest, and attitude are reported in this chapter. Differences between the total experimental and control groups are reported in each section as well as differences between experimental and control students classified into three ability level groups.

Achievement

Total Group Differences. Difference in achievement between experimental and control chemistry students was tested for significance by the analysis of covariance technique. Measures which were used to statistically equate the groups were initial knowledge of physics as measured by pre-experiment achievement, intellectual aptitude as measured by the Otis intelligence test, and previous scholastic performance as evidenced by cumulative high school grade point average. The terminal achievement examination, administered at the end of the school year, was the criterion variable. The techniques used to assess these variables are described in Chapter II of this report.

Intercorrelations. Intercorrelations between the measures employed in the achievement analyses were computed. These coefficients are presented in Table 14. The appropriateness of employing these measures for control purposes can be seen from the relationship of the criterion achievement variable to the three control variables, i.e., pre-achievement ($r=.32$), intelligence ($r=.46$), and grade point average ($r=.38$).

Table 14

Intercorrelations between measures employed in the achievement analyses for 446 chemistry students

Variable	2	3	4
1 Post-experiment Achievement	.32	.46	.38
2 Pre-experiment Achievement		.31	.17
3 Intelligence			.49
4 Grade Point Average			

Having adjusted for initial differences between experimental and control groups, the analysis of covariance results indicated that the difference between performance of the experimental and control students was not statistically significant. The analysis of covariance of experimental and control students' achievement performance is presented in Table 15.

Table 15

Analysis of covariance of experimental and control chemistry students' achievement performance

Source of Variation	Residuals			F
	Degrees of Freedom	Sum of Squares	Mean Square	
Between	1	22.405	22.405	.285
Within	441	34,635.348	78.538	
Total	442	34,657.753		

The criterion and control variable means associated with this analysis are presented in Table 16. It can be seen that the control group mean, after adjustment for initial between-group differences is 60.10 on the final post-experimental achievement test, whereas the experimental group mean, after adjustment, is 60.23

Table 16

Chemistry students' criterion and control variable means

Group	N	Criterion		Control		
		Post-achievement Adjusted	Unadjusted	Pre-test Achievement	IQ	GPA
Experimental	235	60.23	59.75	44.92	112.97	2.93
Control	211	60.10	60.59	45.53	114.89	2.91

Ability Level Group Differences. Even though no significant difference between the experimental and control groups had been revealed by the single classification analyses of variance, it was considered important to test the hypothesis that chemistry students of dissimilar intellectual ability differ in achievement with respect to the filmed instructional method. In order to test this hypothesis, the interaction between ability level and method of teaching, was tested with a multiple analysis of covariance procedure. Both experimental and control groups were divided into equal thirds (high ability, average ability, low ability)[16] according to level of intellectual aptitude as

16. It should be pointed out that since there is a tendency for students enrolling in chemistry classes to possess superior intellectual ability, the terms "high", "average", and "low" must be interpreted only within the framework of the present study. The Otis IQ ranges for the three experimental groups were: High, 135-119; average, 118-109; low, 108-83. For the three control groups the ranges were: high, 136-120; average, 119-111, low 110-92.

measured by the Otis intelligence test. In this analysis it was necessary to randomly delete scores of twenty-six students (twenty-five experimental students and one control student) in order to secure equal sub-groups. This step was taken in order to avoid the necessity of correcting for disproportionality.[17]

In Table 17 the multiple analysis of covariance results are presented for the three sources of variation, i.e., teaching method, ability level, and interaction. It can be seen that the results indicate that differences attributable to the three sources of variation were not statistically significant.

Table 17

Analysis of covariance of achievement performance for experimental and control chemistry students classified by ability

Source of Variation	Residuals			F
	Degrees of Freedom	Sum of Squares	Mean Square	
Method	1	28.629	28.629	.360
Ability	2	95,972	47.986	.604
Interaction	2	81.735	40.868	.514
Within	411	32,662.355	79.470	

In Table 18 the means for the experimental and control students included in the multiple analysis of covariance are presented for post-experiment achievement, pre-experiment achievement, intelligence, and grade point average.

[17]For an explanation of this point, see footnote 15, Chapter III of this report.

Table 18

Means of experimental and control chemistry students (classified by ability) for pre- and post-experiment achievement scores, intelligence scores, and grade point averages

Group		N	Criterion	Control		
			Post-Achievement	Pre-Achievement	IQ	GPA
Experimental	High	70	65.21	46.97	124.49	3.30
	Average	70	59.23	45.40	113.41	2.99
	Low	70	54.33	42.39	100.96	2.51
Control	High	70	65.23	48.31	125.69	3.25
	Average	70	60.66	45.49	115.06	2.86
	Low	70	56.89	42.57	103.97	2.63

In order to compensate for initial differences between groups on the control variables, adjusted means were computed for method groups (experimental and control) and for ability groups (high, average, low). The unadjusted and adjusted post-experiment achievement means for method groups are presented in Table 19. The slight differences between these means and the means obtained in the single classification analysis of covariance is, of course, explained by the deletion of scores of 26 subjects. In Table 20 the unadjusted and adjusted post-experiment achievement means for ability groups are presented.

Table 19

Unadjusted and adjusted post-experiment achievement means for experimental and control chemistry students included in the multiple analysis of covariance

Group	N	Unadjusted Mean	Adjusted Mean
Experimental	210	59.59	59.97
Control	210	60.92	60.54

Table 20

Unadjusted and adjusted post-experiment achievement means for chemistry students classified by ability and included in the multiple analysis of covariance

Group	N	Unadjusted Mean	Adjusted Mean
High Ability	140	65.22	59.57
Average Ability	140	59.76	58.10
Low Ability	140	55.91	61.75

The adjusted means of the experimental and control groups are, as in the case of the single classification analysis of covariance, quite similar. The adjusted means of the ability level group are also similar, although it should be noted that the adjustment process actually reversed the direction of the means. The reason for this apparently unusual inversion phenomenon is discussed in Chapter III of this report.

Interest in Physical Science

Since interest in physical science had been assessed by pre- and post-experiment tests, differences between the experimental and control

groups' interest changes (both for the total group and according to ability levels) were assessed by the Mann-Whitney U Test. This statistical procedure, extremely useful with small samples, can be utilized with large samples such as those involved in the present study by a conversion process resulting in a z value interpretable from a normal curve table.

Differences between groups. Tests of significance for differences between experimental and control group changes in interest in physical science, as measured by the physical science sub-scale of the Thurstone schedule, revealed no significant difference between the groups considered as a whole. The z values yielded from the Mann-Whitney U Test, as well as the group favored by the difference, are presented in Table 21.

Table 21

Significance of differences between interest score changes for experimental and control students classified as a total group and in ability level groups

Group	N	Mann-Whitney Test z value	Group favored by difference
Total			
Experimental	231		
Control	220	1.580	control
High Ability			
Experimental	80		
Control	73	.578	control
Average Ability			
Experimental	74		
Control	71	1.002	experimental
Low Ability			
Experimental	78		
Control	72	2.432*	control

*Significant beyond the .05 level.

When differences were considered between separate ability level groups, however, the difference between the low ability group's change in interest in physical science declined to a greater extent than did the interest of the control group. This difference was significant beyond the .05 level.

Pre- and Post-experimental changes. As might be inferred from the previous analysis, the interest in physical science manifested by the experimental students was in most cases proportionately lower (than that of the control group) at the end of the school year than it had been at the beginning of the study. When differences between the experimental students' pre- and post-experiment interest scores were tested for significance by sign tests, significant losses of interest were seen for the total group, for the high ability group, and for the low ability group. All of these differences were significant beyond the .01 level. This general tendency of reduced interest in physical science can be contrasted with the pattern of interest changes of the control chemistry students. The control group as a whole expressed a loss in interest in physical science, although the loss was rather slight. When the ability level groups were considered separately, the high and the low ability level group evidenced a gain in interest in physical science. The average ability group experienced a loss. None of these shifts in interest for the control group were significant.

Tests of significance for differences between experimental students pre- and post-experiment physical science interest scores are presented in Table 22. Tests of significance for differences between control students' pre- and post-experiment physical science interest scores are presented in Table 23.

Table 22

Significance of differences between experimental chemistry students' pre- and post-experiment physical science interest scores

Group	Sign Test z value	Direction of difference
Total	4.467**	loss
High Ability	2.875**	loss
Average Ability	.756	loss
Low Ability	3.818**	loss

**Significant beyond the .01 level.

Table 23

Significance of differences between control chemistry students' pre- and post-experiment physical science interest scores

Group	Sign Test z value	Direction of difference
Total	.362	loss
High Ability	.124	gain
Average Ability	1.511	loss
Low Ability	.635	gain

Attitude Toward Chemistry as a School Subject

Differences between groups. Differences between experimental and control chemistry students' shifts in attitude toward chemistry as a school subject were tested for significance by the Mann-Whitney U Test. The differences between changes in pre- and post-experimental attitudes for the total

experimental and control groups favored the control group. In other words, the experimental groups' changes in attitude toward chemistry as a school subject were significantly more unfavorable than that of the control group. This difference was significant beyond the .05 level of confidence. When differences between experimental and control students were considered in terms of ability level groups, differences again favored the control groups, although the only significant difference was between experimental and control students of low ability. This difference was significant beyond the .01 level.

The results of tests of significance of differences between attitude scores for experimental and control chemistry groups, considered as total groups and in separate ability groups, are presented in Table 24.

Table 24

Significance of differences between attitude scores for experimental and control chemistry students classified as a total group and in ability level groups

Group	N	Mann-Whitney Test z value	Group favored by difference
Total			
Experimental	203	2.453*	control
Control	171		
High Ability			
Experimental	67	.677	control
Control	57		
Average Ability			
Experimental	68	.580	control
Control	52		
Low Ability			
Experimental	64	3.770**	control
Control			

*Significant beyond the .05 level. ** Significant beyond the .01 level

Pre- and Post-experiment changes. In Table 25 significance of differences between experimental students' pre- and post-experiment attitudes toward chemistry as a school subject are presented. Significance test results for differences between control students' pre- and post-experiment attitudes toward chemistry as a school subject are presented in Table 26.

Table 25

Significance of differences between experimental chemistry students' pre- and post-experiment attitudes toward chemistry as a school subject

Group	Sign Test z value	Direction of difference
Total	6.336**	loss
High Ability	3.469**	loss
Average Ability	2.972**	loss
Low Ability	4.475**	loss

**Significant beyond the .01 level.

Table 26

Significance of differences between control chemistry students' pre- and post-experiment attitudes toward chemistry as a school subject

Groups	Sign Test z value	Direction of difference
Total	7.041**	loss
High Ability	4.582**	loss
Average Ability	4.108**	loss
Low Ability	3.234**	loss

**Significant beyond the .01 level.

Differences between pre- and post-experimental shifts of student attitudes toward chemistry as a school subject were considered separately for both experimental and control groups. All the differences, for the total groups as well as for the ability level groups, indicated significantly less favorable attitudes toward chemistry as a school subject at the end of the study than at the beginning of the study. All differences were significant beyond the .01 level.

Summary of Chemistry Results

Major results of the chemistry phase of the investigation can be summarized as follows:

1. There was no significant difference in achievement performance between the experimental and the control group.

2. There was no significant interaction of teaching method with level of student intelligence.

3. Students in the experimental group manifested proportionately less interest in physical science at the close of the study (in comparison with pre-experiment interest) than did students in the control group. This difference was statistically significant, however, only in the case of students of lower intellectual ability.

4. Although both groups evidenced a more unfavorable attitude toward chemistry as a school subject at the conclusion of the study than they did at the beginning of the investigation, the experimental group's attitudes were significantly more unfavorable than those of the control group, particularly in the case of students of lower intellectual ability.

CHAPTER V

DISCUSSION

Before discussing the major results of the physics and chemistry investigations, it should be pointed out that certain limitations of the present study dictate caution in one's interpretation of these results.

In the first place, results of a single research investigation are obviously far from conclusive. A final evaluation of the effectiveness of the filmed science courses based upon this experiment alone would be highly imprudent. Second, since the experiment was carried out in an actual classroom environment, the possibility of uncontrolled variables operating to contaminate the data is always present. For example, it is well known that teacher competency is a vital determinant in assessing the effectiveness of any instructional method. Although the teachers in the experimental and control groups were comparable on the basis of preparation and experience, it is improbable that they were completely equivalent in terms of teacher effectiveness. Third, the measuring instruments which were used in the experiment to assess student achievement, interest, and attitudes are subject to certain well known limitations. It is conceivable that other researchers, employing different measuring techniques, might obtain results differing from those yielded in the experiment. Fourth, it must be recalled that the films were used according to a particular schedule in the present study. Other schemes for utilizing the films may prove more or less effective. Finally it should be pointed out that while the criterion variables under analysis in the present investigation represent those commonly used in similar evaluations, they certainly do not exhaust the criteria which might legitimately be employed in such an investigation. With these limitations in

mind, the major results of the physics and chemistry examination will now be treated.

Results of the achievement analyses indicated that whereas the chemistry films proved as effective as conventional methods, students taught with the filmed physics series did not achieve as well as students who were taught physics in a conventional manner. This latter difference indicated that the physics films, as they were employed in the present research, did not promote learning comparable to that produced under ordinary instructional conditions.

The reasons for the differences in the effectiveness of the chemistry and the physics series are not clear. One might speculate that the physics series may be technically inferior to the chemistry series. The latter series was produced expressly for the filmed high school course. Hence, in the chemistry series considerably more editing was possible than with the physics series. These considerations, plus previous experience gained from the production and use of the physics series, may have rendered the quality of the chemistry films superior to that of the physics films. It is also possible that the nature of the chemistry content lends itself more readily to the filmed approach. These explanations are admittedly conjectural, for at this juncture it is impossible to identify with certainty the factors contributing to the differences revealed in the present study between the effectiveness of the physics and chemistry series.

An interesting point regarding achievement involved the fact that for both chemistry and physics no significant differences were discerned in the achievement of students of differential intelligence levels. These findings may be contrasted with results of an investigation conducted by

Engelhart et al.(1958) in which students of average intellectual ability tended to respond more favorably to the physics films (via television) than students of extremely high or low intellectual ability.

Analyses involving interest in physical science as the criterion revealed that both experimental and control students evidenced reduced interest in physical science at the conclusion of a year of physical science instruction in comparison to the interest they manifested at the beginning of that year. Similiar results have been observed by other investigators (Noall & Winget, 1959). One explanation of this phenomenon may be that the reduction of interest in physical science represents a healthy awakening on the part of the student to the exacting demands of vocations in the physical sciences.

Although contrasts between experimental and control groups with respect to student interest in physical science, (both in physics and chemistry) yielded no significant differences, there was a general pattern tending to favor the film group in the case of physics and the non-film group in the case of chemistry. Since the differences were, for the most part, non-significant it can be concluded that the film and non-film approaches apparently foster comparable student interest in physical science.

With respect to students' attitudes toward physics or chemistry as a school subject, both groups manifested markedly less favorable attitudes at the end of the experimental period than at the beginning. In practically all of the comparisons between students' pre- and post-experiment attitudes toward either chemistry or physics as a school subject, significantly less favorable attitudes were observed at the close of the school year. This phenomenon, as in the case of interest in physical science, may represent

a recognition by students of difficulties associated with physical science courses, difficulties that at the first of the year, though dimly perceived, may have been obscured by the exciting prospect of "becoming a scientist".

In contrasting attitudinal differences between experimental and control groups, significant differences favoring the control groups (both physics and chemistry) were observed. That is, attitudes of the control students toward the school subject, though less favorable than at the beginning of the year, were proportionately less negative than attitudes of the experimental students. It appears that use of films fosters attitudes which are even more unfavorable toward physics and chemistry as school subjects than the attitudes promoted by courses taught in a conventional mode.

In conclusion, the results of the major analyses for both physics and chemistry seem to create doubts concerning the value of teaching science courses via film, particularly in the case of the physics series. While the limitations cited at the outset of this discussion suggest that the findings of this experiment are far from conclusive, research of this type should make it incumbent upon proponents of the filmed science courses to supply empirical evidence that the filmed technique produces educational gains which are at least comparable to those yielded by ordinary instructional methods. With a view to sound fiscal policies in the secondary school, the considerable cost associated with their purchase should dictate that more evidence supporting the effectiveness of the filmed science courses must be presented before a favorable judgment regarding their educational usefulness can be reached.

CHAPTER VI

END-OF-COURSE REACTIONS TOWARD FILMS

Student Opinions

Student opinions regarding the science films were obtained through use of a questionnaire. Experimental students' responses to questionnaire items were analyzed by two methods. First, gross percentages of student responses to each item were enumerated. Second, responses of students classified according to intelligence levels (high third, average third, low third) were statistically analyzed for the purpose of differentiating between the ability groups' reactions to varied aspects of the films. Opinions of experimental physics and chemistry students were considered separately.

Questionnaire Responses

Physics. The most general reflection of physics students' opinions toward the films can be seen in their ratings of the films on the basis of how much they learned from them. In terms of learning, student ratings were scattered, i.e., excellent (11%), good (29%), average (23%), fair (21%), poor (16%). The same situation prevailed in rating the films on the basis of how much students had enjoyed them: excellent (7%), good (32%), average (23%), fair (13%), poor (25%).

From a negative standpoint, most students thought that the course material was presented too rapidly (66%), that use of the films allowed too little time for classroom discussion (59%), and that insufficient time was available for laboratory work (78%). Over half of the students who expressed a preference (58%) indicated that they would have preferred their physics course taught by ordinary methods rather than by films.

Chemistry. As in the case of student reactions to the physics films,

experimental chemistry students were divided with respect to how they rated the films in terms of how much they had learned from them, i.e., excellent (10%), good (23%), average (20%), fair (24%), poor (23%). On the basis of how much they had enjoyed the chemistry films, students responded in a more negative manner: excellent (4%), good (19%), average (20%), fair (26%), poor (31%).

Like the experimental physics students, a majority of those viewing the chemistry films believed that the course material was presented too rapidly (77%), that the films allowed too little time for classroom discussion (77%), and that insufficient time was available for laboratory work (79%). Over two-thirds of the pupils who expressed a preference (71%) would rather have been taught by ordinary methods than by films.

Questionnaire Responses of Ability Level Groups

Physics. Responses to nine items of the questionnaire were subjected to chi square analyses in order to determine if physics students classified according to intellectual ability responded differently to the items. For purposes of this analysis the experimental group was once more divided into approximately equal thirds according to student scores on the Otis intelligence test. In Table 27, chi square values yielded by contrasting responses of the three experimental physics ability groups to the nine questionnaire items are presented. Only two of the nine chi square values were significant.

There was a significant difference in the way the ability groups estimated the effect that the films method had on the relationship between the classroom teacher and themselves. Students of higher

Table 27

Chi square values for responses of experimental physics students classified by ability to nine questionnaire items

Item	df	Chi Square
Would you prefer that this course had been taught by ordinary methods rather than by films? (1) yes, (2) no, (3) uncertain	4	6.699
On the average about how much time do you spend studying for this subject each day? (1) 0 to 1 hr, (2) 1 hr., (3) 2 hrs., (4) 3 hrs., (5) 4 or more hrs.	2	1.575
How would you classify your teacher's attitude toward the science films? (1) very favorable, (2) favorable, (3) neutral, (4) unfavorable, (5) very unfavorable	6	13.342*
What effect do you think that the filmed course instruction method had on the relationship between you and your classroom instructor? (1) very helpful, (2) helpful, (3) no effect, (4) harmful, (5) very harmful	4	12.568*
How would you classify the rate of speed at which the course material is presented in films? (1) much too fast, (2) too fast, (3) just right, (4) too slow, (5) much too slow	4	5.586
Regarding time for classroom discussion, how would you classify this filmed course? (1) a great deal of time for classroom discussion, (2) adequate time for classroom discussion, (3) too little time for classroom discussion	2	1.141
Regarding your use of the laboratory, how would you classify this filmed course? (1) a great deal of time for laboratory work, (2) sufficient time for laboratory work, (3) too little time for laboratory work	2	.953
On the basis of how much you learned from them, how would you rate the films? (1) excellent, (2) good, (3) average, (4) fair, (5) poor	8	7.198
On the basis of how much you enjoyed them, how would you rate the films? (1) excellent, (2) good, (3) average, (4) fair, (5) poor	8	13.255

*Significant beyond the .05 level.

intelligence expressed the opinion that the films had been detrimental to the rapport between the classroom teacher and themselves, while students of lower ability thought that the use of films had improved their relationship to the classroom teacher. This difference was significant beyond the .01 level.

In addition, the ability groups responded differently regarding their perception of their teacher's attitude toward the science films. More of the average ability group considered their teacher's attitude toward the films to be neutral while a greater proportion of the low ability groups believed that their teachers's attitude toward the films was favorable. This difference was significant beyond the .05 level.

Chemistry. Chemistry students' responses to the same questionnaire items were analyzed by chi square tests in order to determine significance of differences between responses of students classified into the three ability level groups. In Table 28, chi square values yielded by contrasting responses of the experimental chemistry ability groups to the nine questionnaire items are presented. In four of the comparisons significant differences were observed.

Students were asked if they preferred the course to have been taught by ordinary methods rather than by films. A greater proportion of high ability students responded negatively to this question than did the students of average and low ability. In other words, a greater proportion of high ability students were satisfied with the film method of presentation. This difference was significant beyond the .01 level. It should be noted that in spite of the fact that a greater proportion of high ability students (than average or low ability students) preferred films, over half of the high ability group preferred ordinary instructional methods for the course.

Table 28

Chi square values for responses of experimental chemistry students classified by ability to nine questionnaire items

Item	df	Chi Square
Would you prefer that this course had been taught by ordinary methods rather than by films? (1) yes, (2) no, (3) uncertain	4	16.930**
On the average about how much time do you spend studying for this subject each day? (1) 0 to 1 hr., (2) 1 hr., (3) 2 hrs., (4) 3 hrs., (5) 4 or more hrs.	4	5.541
How would you classify your teacher's attitude toward the science films? (1) very favorable, (2) favorable, (3) neutral, (4) unfavorable, (5) very unfavorable	6	3.232
What effect do you think that the filmed course instruction method had on the relationship between you and your classroom instructor? (1) very helpful, (2) helpful, (3) no effect, (4) harmful, (5) very harmful	4	12.809*
How would you classify the rate of speed at which the course material is presented in films? (1) much too fast, (2) too fast, (3) just right, (4) too slow, (5) much too slow	4	14.650**
Regarding time for classroom discussion, how would you classify this filmed course? (1) a great deal of time for classroom discussion, (2) adequate time for classroom discussion, (3) too little time for classroom discussion	2	.171
Regarding your use of the laboratory, how would you classify this filmed course? (1) a great deal of time for laboratory work, (2) sufficient time for laboratory work, (3) too little time for laboratory work	2	1.620
On the basis of how much you learned from them, how would you rate the films? (1) excellent, (2) good, (3) average, (4) fair, (5) poor	8	14.817
On the basis of how much you enjoyed them, how would you rate the films? (1) excellent, (2) good, (3) average, (4) fair, (5) poor	8	18.793*

*Significant beyond the .05 level. **Significant beyond the .01 level.

There was a significant difference in the way the ability groups estimated the effect that the film method had on the relationship between the classroom teachers and themselves. Students in the high ability group believed that the films had been more harmful to the rapport between the classroom teacher and themselves than did students of low ability. (This was the same pattern noted in the case of physics students' responses to this item.) The difference was significant beyond the .05 level.

A greater proportion of lower ability students believed that the rate of speed at which the course was presented in the films was much too rapid. Although students of high and average ability believed that the course material was presented in the films too rapidly, a significantly lower proportion believed that the film material was presented <u>much</u> too rapidly. This difference was significant beyond the .01 level.

The final difference noted between the ability groups was in their ratings of the films on the basis of how much they had enjoyed them. A smaller proportion of the low ability group gave favorable ratings to the films on this point, while a higher proportion of the average and high ability groups rated the films favorably in terms of enjoyment. This difference was significant beyond the .05 level.

Strengths, Weaknesses, and Suggestions for Improvement

<u>Physics and chemistry</u>. Students in the experimental group were asked in the questionnaire to list what they considered to be the major strengths and weaknesses of the films and to make suggestions for their improvement. Since the comments of chemistry and physics students were remarkably similar, responses of both groups were combined.

The most commonly noted strength of the films was that their use

made possible the observation of laboratory experiments which might not be practicable in ordinary high school classrooms. Over one-half of the student respondents cited this as a major strength of the films. In addition, the following strengths (in order of decreasing frequency) were noted: (1) The instructor was commended for his excellence as a specialist in the field. (2) Subject matter was well covered. (3) The material treated in the films was regarded as high level. (4) The film instructor could explain difficult concepts better than a typical classroom teacher.

Among the most common weaknesses cited by the students (in order of decreasing frequency) were: (1) The filmed material was presented at too rapid a pace. (2) The films were not sufficiently interesting. (3) The material treated in the films was too difficult and concepts were too hard to understand. (4) There were not enough first hand experiences. (5) There was insufficient classroom discussion time. (6) Questions could not be directed toward the film instructor. (All of the above weaknesses were indicated by at least one-fifth of the students responding to the questionnaire.)

In addition, suggestions for improvement in the use of the films were offered by the respondents. The most common suggestion was that fewer films should be shown. In addition, the following suggestions (in order of decreasing frequency) were made by many of the respondents: (1) More first hand experiences in laboratory and classroom should be provided. (2) More color films are needed. (3) More classroom discussion time is necessary. (4) Material should be presented in the films at a slower rate of speed. (5) Only textbooks which are coordinated with films should be used. (6) Films should be shorter. (7) Outlines of each film should be provided in advance. (8) Certain mannerisms of the film instructor (such

as wearing the same suit) should be corrected.

Teacher Opinions

Although only a limited number of teachers taught their science courses by using the films, their end-of-course reactions toward the filmed series may lend some insight into the value of this instructional approach.

Physics. The majority of the six experimental physics teachers rated the films high on the basis of how much students had learned from them. Four of the teachers rated the films good on this point, one rating the films fair and one poor. On the basis of how much students had enjoyed them, the teachers were less optimistic. Only one of the teachers rated the films good in terms of student enjoyment, three rating them average, one fair, and one poor.

All six of the teachers believed that the films, as they were used in the present study, allowed too little time for laboratory work. Five of the six thought that the films allowed too little time for class discussion and that the rate of speed at which the material was presented in the films was too fast.

All of the teachers thought that they had benefitted personally from viewing the films. Four of the instructors believed that they had derived considerable benefit, while two indicated that they had profitted to some extent.

In the estimation of the participating teachers, the films are most effective with the upper ability levels. Four teachers considered the films to be more beneficial for the upper ten per cent while two indicated that they were most beneficial for the upper 25 per cent.

Several teachers offered the suggestion that the effectiveness of the

films could be improved if teachers were allowed to select a limited number of films from the series rather than employ the series in its entirety.

Chemistry. Opinions of the seven teachers who employed the chemistry films were somewhat more negative toward use of the films than were opinions of physics teachers.

Six of the seven instructors rated the films average or below in terms of how much students learned from them. On the basis of how much students enjoyed them, three teachers rated the films only fair and three rated them as poor. A majority of teachers expressed the opinion that the films were most effective with students of markedly superior ability.

All of the teachers indicated that the films, as they were used in the present study, allowed too little time for laboratory work and class discussion. All but one of the teachers thought that course material was presented too rapidly.

On the positive side, all chemistry teachers believed that they had benefitted personally from seeing the films. However, all but one teacher indicated that they would have preferred to teach their chemistry courses by ordinary methods rather than by films.

Students' Attitudes Toward Filmed Courses

Student's attitudes toward filmed courses per se (not a particular filmed course such as the physics series or the chemistry series) were assessed by the Attitude Toward Film Courses Scale which was designed for the present project. This Likert-type scale consisted of thirty items regarding filmed courses. Students who were being taught via films were asked to indicate strong agreement, agreement, uncertainty, disagreement,

or strong disagreement with each of the thirty statements included in the scale. Items were scored by assigning a value of four points to the response most favorable toward filmed courses, three points to the next most positive response, and so on to a zero for the least favorable response.

In order to determine the degree of internal consistency of the items, student responses for both physics and chemistry were pooled. The upper 27 per cent and lower 27 per cent of this group (in terms of total score) were selected. In order to determine the discriminating efficiency of the thirty items, the responses of these two groups to each item were contrasted by chi square analyses. Twenty-nine of the items discriminated beyond the .01 level of confidence and the 30th item discriminated beyond the .02 level of confidence. All items were, therefore, considered satisfactory. (On the basis of the item analysis of the instrument, it would appear that the scale can be satisfactorily employed by other researchers dealing with problems similar to the one under consideration in this report.)

Having determined the suitability of the items in the scale, scores were again separated into chemistry and physics groups. Scores of chemistry and physics students were contrasted in order to determine differences, if any, between the attitudes of the two groups which had been exposed to filmed courses. The difference between the two groups was tested by the Mann-Whitney U Test. This analysis revealed that there was no significant difference between the attitudes of the two groups. The z value yielded by this comparison was 1.085 and was not statistically significant. The physics group's attitudes toward filmed courses were slightly more favorable than attitudes of the chemistry students.

Accuracy of Grade Estimation

The final comparison between the experimental and control groups contrasted the accuracy of grade estimation made by students who were taught by film with those who were taught in a conventional manner. Approximately two weeks before the close of the school year all students were asked to estimate the grade they thought they would receive in the course. The grades actually assigned to pupils were obtained from the teachers at the conclusion of the school year. Differences between the accuracy of estimation of experimental and control students (for chemistry and physics) were assessed by a chi square test.

There was no significant difference between the accuracy of grade estimation of the experimental and control physics students. The estimates of these two groups are presented in Table 29.

Table 29

Grade estimation accuracy of experimental and control physics students

Group	Estimated one grade too high	Estimated accurately	Estimated one grade too low
Experimental	37	85	4
Control	36	87	15

Chi square = 5.530, df=2, not significant.

In Table 30, grade estimation accuracy of experimental and control chemistry students is presented. The difference between the estimation accuracy of these two groups was significant beyond the .01 level. As can be seen from Table 30, a greater proportion of the experimental students tended to inaccurately estimate their grades.

This was particularly true in the case of grade underestimation, where four times as many experimental as control students estimated that they would receive one grade lower than the grade they actually received. This suggests that chemistry students being taught by the films did not have as clear a perception of their relative standing in class as did chemistry students taught in a conventional fashion.

Table 30

Grade estimation accuracy of experimental and control chemistry students

Group	Estimated one grade too high	Estimated accurately	Estimated one grade too low
Experimental	56	135	34
Control	36	167	7

Chi square = 25.71, df = 2, significant beyond the .01 level.

An inspection of the various types of end-of-course reactions of both students and teachers who participated in this investigation reflects a generally negative tone toward the science films as they were used in this experiment, particularly in the case of the teacher opinions. While it may be argued that the measures reflecting end-of-course reactions were not the most sensitive, their use provides an estimation of student and teacher reactions toward the flms---reactions which tended to be unfavorable regarding the use of filmed science courses.

REFERENCES

Anderson, K. E. & Montgomery, F. S. An evaluation of the introductory physics course on film. Sci. Educ., 1959, 43, 386-394.

Clark, K. E. Generalized attitude scales. In O. K. Buros (Ed.), The Fourth Mental Measurements Yearbook. Highland Park, New Jersey: The Gryphon Press, 1953. pp. 46-47.

Engelhart, M. B., Schwachtgen, E. C., & Nee, Mary M. Chicago public schools television instruction experiment in high school physics. Amer. J. Physics, 1958, 26, 347-349.

Noall, M. F. & Winget, L. Staff utilization studies help Utah educators-the physics film project. Nat. Ass. Second. Sch. Princ. Bull., 1959, 43, 183-195.

Science Research Associates, Inc. Confidential report to Encyclopaedia Brittanica Films, Inc. on a pilot study of evaluation concerning the use of the White physics films. Chicago, 1958.

The Wisconsin physics film evaluation project. Madison: University of Wisconsin.

(APPENDIX)

ATTITUDE TOWARD FILMED COURSES SCALE

(All Rights Reserved)

Joseph M..Sadnavitch and W..James Popham

Name_____ School_____

Subject_____

DIRECTIONS: The following is a list of statements about filmed courses. Read each item carefully and mark your response according to the choices given below. The correct answer should reflect your true feeling regarding each statement. Please respond to every item. Your score on this scale will in no way affect your grade in any course. You are asked to mark each item by drawing a circle around the letter or letters which represent your reactions as follows:

SA if you agree completely with the statement

A if you agree in general but wish to modify it somewhat

U if your attitude is undecided

D if you disagree but with certain modifications

SD if you completely disagree

1.	Taking a course on film makes the student feel keenly interested in the subject.	SA	A	U	D	SD
2.	No sane person would take a course on film.	SA	A	U	D	SD
3.	A course on film does not motivate students to do better work.	SA	A	U	D	SD
4.	Taking a course on film is too boring.	SA	A	U	D	SD
5.	The content presented on film moves so rapidly that the student can't keep up.	SA	A	U	D	SD
6.	Taking a course on film should be required of all students.	SA	A	U	D	SD
7.	A suitable class atmosphere is impossible when a filmed course is taken.	SA	A	U	D	SD
8.	Filmed courses aid in developing a sound relationship between the student and classroom teacher.	SA	A	U	D	SD
9.	A student taking a filmed course can never really feel like he knows the teacher in the film.	SA	A	U	D	SD
10.	Taking a course on film is all bunk.	SA	A	U	D	SD

(over)

11. Filmed courses will give students the ability to interpret situations they will meet in real life. SA A U D SD

12. Courses on film make it easier for the student to see and know what is happening. SA A U D SD

13. Filmed courses are so difficult that they should be used only on the college level. SA A U D SD

14. Courses on film eliminate the possibility of taking notes.. SA A U D SD

15. The best class atmosphere is developed while taking a filmed course. SA A U D SD

16. A course on film interferes with learning. SA A U D SD

17. Taking a course on film is the best school experience anyone could have. SA A U D SD

18. The average student gets nothing worth having from a filmed course. SA A U D SD

19. Filmed courses are easy enough to be used at the elementary school level. SA A U D SD

20. Courses on film provide plenty of opportunity for taking notes. SA A U D SD

21. Filmed courses are the best method used in school. SA A U D SD

22. Filmed courses move at a pace which allows the student to keep up easily. SA A U D SD

23. Filmed courses are the best way to hold a student's interest. SA A U D SD

24. Filmed courses are the worst method used in school. SA A U D SD

25. Courses on film do not provide enough time for class discussion. SA A U D SD

26. Using films rather than lectures is the most effective way to cover the course content. SA A U D SD

27. Taking a course on film provides better content coverage than the usual classes. SA A U D SD

28. Filmed courses provide sufficient time for class discussion. SA A U D SD

29. The content on films tends to contradict text materials. SA A U D SD

30. A course on film causes certain areas to be slighted in coverage. SA A U D SD